

SCUBA OBSERVATIONS IN EASTERN LAKE MICHIGAN NEAR MUSKEGON HARBOR,
13-14 SEPTEMBER 1979.

By: John A. Dorr III
David J. Jude

Under contract with
Michael Baker, Jr., Inc.

Great Lakes Research Division
The University of Michigan
Ann Arbor, Michigan

1980

ACKNOWLEDGMENTS

This study was funded by Michael Baker, Jr., Inc. (Beaver, Pennsylvania). To their representatives, Edward Wiley and James Ulinski, we are indebted for congenial treatment through all phases of contract negotiation and consummation. Nelson Navarre from the Great Lakes and Marine Waters Center was also very helpful during these phases. Our thanks are extended to Steve Schneider for publication assistance, Loren Flath for preparation of graphics and to Jan Farris and Betsy Lesser for typing. Finally, we are especially grateful for the suggestions, efforts and acute observations by our fellow divers, John Krezoski, Karl Luttrell and Thomas Rutecki.

INTRODUCTION

Presented here is a compendium of physical and biological information obtained from five SCUBA dives in eastern Lake Michigan in the vicinity of the Muskegon Harbor breakwaters, 13-14 September 1979. The study was performed to assist the State of Michigan artificial reef project. Color photographs (35 mm transparencies) were also taken at each station documenting bottom topography and configuration. These photographs are available from Michael Baker, Jr., Inc., Beaver, Pennsylvania. Diving was performed to document existing physical and biological conditions in the lake including any unique fish-spawning areas or substrates, irregular lake-bottom terrain, areas of locally increased turbidity or silt and presence of aquatic macrophytes. Use of SCUBA permits direct observation and hand sampling of an area; data obtained may supplement or be correlated with data obtained during other (primarily mechanical) sampling efforts in the study area. Also, use of SCUBA permits visual comparisons of lake habitat among areas and observations of patterns or gradients associated with physical and biological features (e.g., depth of silt or density of gastropods as a function of water depth). Observations were made by John A. Dorr III, John R. Krezoski, Karl S. Luttrell and Thomas L. Rutecki.

METHODS

During 13-14 September, daylight underwater observations were made using SCUBA in the vicinity of the Muskegon Harbor breakwaters, Lake Michigan. A 7-m Boston Whaler served as the surface-support vessel. The area along five transects (Fig. 1, Table 1) was examined during this period. Two divers were towed by boat via underwater sleds; during the tow, the boat stopped at stations located at 7.6, 9.1, 10.6, 12.1 and 13.6 m along transect dive no. N1 (0.4 km north of breakwaters), N4 (1.6 km north of breakwaters), S1 (0.4 km south of breakwaters) and S4 (1.6 km south of breakwaters). Divers were also towed by sled along transect S2 (0.8 km south of breakwaters) on 14 September, but rough lake conditions prohibited stops at scheduled stations.

Photographs were taken by one diver at all stations along all transects except S2 (0.8 km south of breakwaters). Another diver made and recorded observations of some physical and biological features of the lake bottom at each station on water-resistant paper according to a prearranged format (Fig. 2).

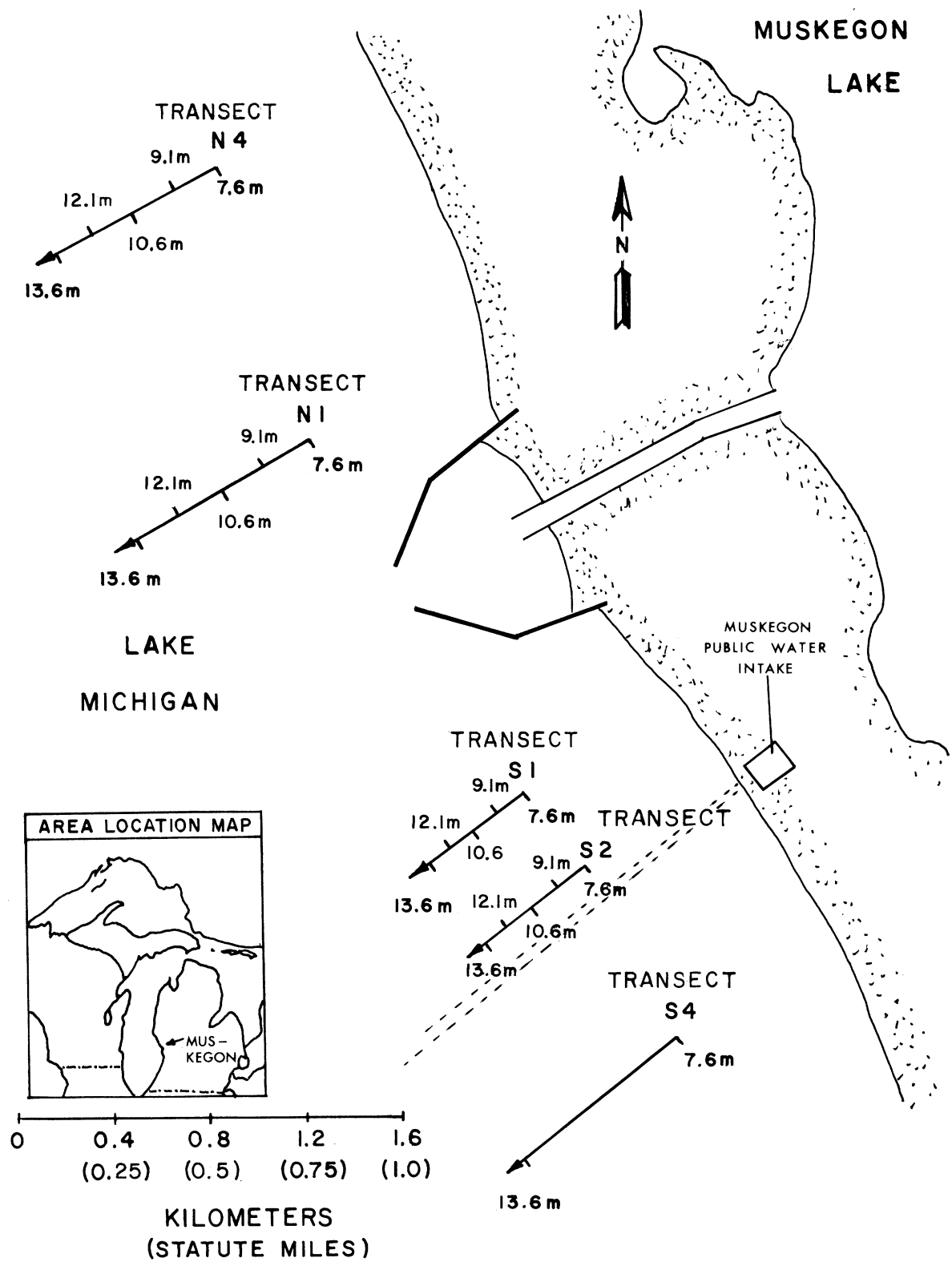


FIG. 1. Scheme of the Muskegon SCUBA survey area showing the five underwater transects swum to monitor bottom topography and biota. S1, S2, S4, N1, N4 = transects 0.4, 0.8 and 1.6 km south and 0.4 and 1.6 km north, respectively, of the outer breakwaters at Muskegon, Michigan.

TABLE 1. Summary of survey SCUBA dives performed in eastern Lake Michigan near the Muskegon Harbor breakwaters, 13-14 September 1979. Times given are for the beginning of each transect swim.

Date	Time (EST)	Dive duration (min)	#Transect and Location	Station no.	Depth (m)	Team
13 Sep	1300	85	S1-0.4 km south	1	7.6	Dorr, Krezoski
				2	9.1	
				3	10.6	
				4	12.1	
				5	13.6	
13 Sep	1520	60	N1-0.4 km north	1	7.6	Dorr, Luttrell
				2	9.1	
				3	10.6	
				4	12.1	
				5	13.6	
13 Sep	1700	60	S4-1.6 km south	1	7.6	Dorr, Luttrell
				2	9.1	
					10.6	
					12.1	
					13.6	
13 Sep	1843	50	N4-1.6 km north	1	7.6	Dorr, Luttrell
				2	9.1	
					10.6	
					12.1	
					13.6	
14 Sep	1150	25	S2-0.8 km south	*	7.6- 13.6	Dorr, Rutecki

S or N refers to south or north of the Lake Michigan breakwaters at Muskegon (see Fig. 1).

* Station observations omitted. See text for explanation.

PHYSICAL AND BIOLOGICAL OBSERVATIONS
GLRD SCUBA SURVEY

Transect No.			
Station No.			
Time			
Distance from start			
<u>Physical</u>			
Temp. (F)			
Depth (ft)			
Horizontal visibility (m)			
Substrate (Composition/Thickness (mm)/ Percent)	/ /	/ /	/ /
	/ /	/ /	/ /
	/ /	/ /	/ /
Floc layer (mm)			
Inorganic debris			
Bottom profile			
Ripple marks (Direction from/Height/Width/ Length) (cm)	/ / /	/ / /	/ / /
<u>Biological</u>			
Organic detritus			
Periphyton			
Loose algae			
Invertebrates (Taxon/Number/Density)	/ /	/ /	/ /
	/ /	/ /	/ /
	/ /	/ /	/ /
Fish (Species/Number/Density)	/ /	/ /	/ /
	/ /	/ /	/ /
	/ /	/ /	/ /
Sample collected			
Additional comments			

T (trace) = discernible, but not measurable
 F (few) = 1-10 M (many) = 11-50 N (numerous) = 51-100 A (abundant) = 101-500
 VA (very abundant) = 500 or more

FIG. 2. Data sheet used by SCUBA divers to record physical and biological features of inshore eastern Lake Michigan bottom, 13-14 September 1979. Data were recorded underwater on water-resistant paper.

Additional diver observations were tape recorded at the surface following each dive. Surface-support personnel recorded time of dive and some lake and weather conditions at the beginning and end of each dive. During diving on transect S2 (0.8 km south of breakwaters), observations were not recorded on paper underwater, but were committed to memory and tape recorded at the surface after the dive; photographs were omitted. Observations from all dives were later compiled and transcribed.

Length of each transect was estimated from scaled map measurements (chart no. 767, Muskegon Harbor and Muskegon Lake, Lake Survey Center, National Oceanic and Atmospheric Administration, 1972) of distances between lake depth contours. Transect width (W) was calculated according to the following formula:

$$W = 2v + d \quad (1)$$

where v = mean horizontal visibility at the bottom summed over transect stations and multiplied by 2 (no. of divers observing) plus the constant d (distance between divers = 1 m). Area was calculated according to the following formula:

$$\text{area (A)} = \text{transect length (L)} \times \text{width (W)} \quad (2)$$

or

$$A = L(2v + d). \quad (3)$$

Areas examined were, generally, comparable in size; horizontal visibility may have been underestimated during diving on transect S1 (0.4 km south of harbor) and diminished during diving on transect N4 (1.6 km north of harbor) because of reduced daylight.

Observations (written underwater, tape recorded and noted by surface personnel) were compiled and divided into the following categories: description of bottom, presence of organic material and biological notes. Between-station observations were also noted. Since visual observations tend to be subjective in the absence of exact counts or measurements, the following terms used in this report are defined: trace = discernible but not measurable, few = 1-10, many = 11-50, numerous = 51-100, abundant = 101-500 and very abundant = more than 500. Bottom composition was described loosely as: fine sand (grains barely discernible to sight and touch), medium sand (grains readily discernible to sight and touch) or coarse sand (grains large and coarse to touch). Organic detritus refers to fragmented pieces of terrestrial material (primarily vegetation) and aquatic debris (dead algae and phytoplankton, mollusc shells, etc.). Floc refers to the loose accumulation of fine particulate material (consisting primarily of sediment, some periphyton, organic and diatomaceous material) often producing a silty overburden on the sand bottom. When describing ripple marks, high refers to trough-to-crest distance, (i.e., amplitude), apart refers to crest-to-crest distance, (i.e., wavelength), long refers to length of individual ripple marks and from refers to direction of generation; dimensions were averages of estimates. Objects observed during diving, which are macroscopic in nature, were limited primarily to demersal organisms and did not include organisms living within the sediment.

OBSERVATIONS

Observations are presented by station for each transect except S2 (0.8 km south of harbor); between-station observations follow station observations. Observations for transect S2 are presented as between-station observations.

Transect S1 (0.4 km south of harbor)

Transect dimensions: length - 500 m
width - 4.6 m²
area - 2300 m²

Depth range: 7.6-13.6 m

Secchi disc: station 1 - 3.0 m; station 5 - 3.0 m

Water temperature: station 1 - 17.5 C surface, 16.5 C bottom; station 5 - 17.0 C surface, 15.0 C bottom

Air temperature: 15 C

Cloud cover: partly cloudy

Wind: NW, 16-24 km/h

Seas: NW, wave height 0.6-1.0 m

Weather: cool, dry, breezy

Station 1 - Depth: 7.6 m

Bottom: medium sand, ripple marks - SW, 4 cm high, 8 cm apart, less than 100 cm long

Organic material: none

Biological notes: none

Station 2 - Depth: 9.1 m

Bottom: medium to fine sand, ripple marks - SW, 4 cm high, 13 cm apart, less than 100 cm long

Organic material: none

Biological notes: none

Station 3 - Depth: 10.6 m

Bottom: fine sand, ripple marks indistinguishable

Organic material: few clumps of detritus (about 2-cm diameter or less)

Biological notes: none

Station 4 - Depth: 12.1 m

Bottom: fine sand, ripple marks - SE, less than 2 cm high, width variable, 10 cm long

Organic material: trace of floc

Biological notes: none

Station 5 - Depth: 13.6 m

Bottom: fine sand, ripple marks - SE, less than 2 cm high, width and length variable.

Organic material: about 1 mm of floc

Biological notes: none

Between-station observations:

- 1) Bottom was smooth and flat; profile was unbroken.
- 2) A slight (1 mm) accumulation of floc was noted at

- depths of 12.1 m or more.
- 3) A few small (4-cm diameter or less) clumps of loose algae were noted along the transect.
 - 4) One small stick was observed between stations 1 and 2; a few were seen between stations 4 and 5. One log (0.5-m diameter, 3 m long) was noted near station 3; a small amount of periphyton (less than 5 mm long) was attached to it.
 - 5) Numerous empty snail shells and snail tracks were observed at stations 3-5; live snails were not observed.

Transect N1 (0.4 km north of harbor)

Transect dimensions: length - 1000 m
width - 6 m
area - 6000 m²

Depth range: 7.6-13.6 m

Secchi disc: station 1 - 3.0 m; station 5 - 4.0 m

Water temperature: station 1 - 17.5 C surface and bottom; station 5 - 17.5 C surface, 16.5 C bottom

Air temperature: 15 C

Cloud cover: partly cloudy

Wind: NW, 16-24 km/h

Seas: NW, wave height 1.0-1.3 m

Weather: cool, dry, breezy

Station 1 - Depth: 7.6 m

Bottom: fine sand, ripple marks - W, 4 cm high, 18 cm apart, less than 100 cm long

Organic material: 1 mm of floc

Biological notes: few small (less than 4-cm diameter) clumps of loose algae (primarily Cladophora with epiphytes) were noted; one sample was collected

Station 2 - Depth: 9.1 m

Bottom: fine sand, ripple marks - NW, 3 cm high, 14 cm apart, less than 100 cm long

Organic material: none

Biological notes: few small clumps of algae were noted but none were sampled

Station 3 - Depth: 10.6 m

Bottom: fine sand, ripple marks - N, 4 cm high, 18 cm apart

Organic material: few small pieces of detritus, patchy areas of floc 1 mm thick

Biological notes: none

Station 4 - Depth: 12.1 m

Bottom: fine sand, ripple marks - SW, 5 cm high, 10 cm apart, less than 100 cm long

Organic material: patchy areas of floc 1 mm thick

Biological notes: few sphaeriid (fingernail clam) shells were noted along with a few live snails (probably Gyraulus spp.)

Station 4 - Depth: 12.1 m
Bottom: fine sand, ripple marks indistinguishable
Organic material: few fish fecal pellets, trace of floc
Biological notes: few sphaeriid shells, many gastropods

Station 5 - Depth: 13.6 m
Bottom: fine sand, ripple marks variable
Organic material: few fish fecal pellets, trace of floc
Biological notes: few sphaeriid shells, many gastropods

Between-station observations:

- 1) Ripple marks were poorly developed, often indistinguishable.
- 2) A few (2-3) fragments of wood 10-25 cm in diameter were noted.
- 3) Fish fecal pellets were observed regularly but were low in abundance; pellets were from fish probably 30 cm or more in length (i.e., large fish such as suckers, carp or salmonids). Unique occurrence of pellets along this transect was unexplained.
- 4) Snails were observed primarily at deeper (10.1-13.6 m) stations. Snails may have been slightly more abundant along this transect relative to other transects.

Transect N4 (1.6 km north of harbor)

Transect dimensions: length - 900 m
width - 5.2 m₂
area - 4680 m²

Depth range: 7.6-13.6 m

Secchi disc: station 1 - 2.5 m; station 5 - 2.5 m

Water temperature: station 1 - 17.0 C surface, 16.5 C bottom
station 5 - 17.0 C surface, 15.0 C bottom

Air temperature: 16.0 C

Cloud cover: partly cloudy

Wind: NW, 16-24 km/h

Seas: NW, wave height 0.6-1.0 m

Weather: cool, dry, breezy

Station 1 - Depth: 7.6 m
Bottom: fine sand, ripple marks - N, 4 cm high, 19 cm apart, less than 100 cm long
Organic material: trace of floc
Biological notes: none

Station 2 - Depth: 9.1 m
Bottom: fine sand, ripple marks variable and poorly developed
Organic material: trace of floc
Biological notes: few sphaeriid shells

Station 3 - Depth: 10.6 m
Bottom: fine sand, ripple marks indistinguishable
Organic material: trace of floc
Biological notes: few sphaeriid shells

Station 4 - Depth: 12.1 m

Station 5 - Depth: 12.1 m
Bottom: fine sand, ripple marks - SE, 5 cm high, 15 cm
apart, less than 100 cm long
Organic material: patchy areas of floc 1 mm thick
Biological notes: few sphaeriid shells were noted

Between-station observations:

- 1) Surface waves could be felt on the bottom at all stations; entrainment and vertical movement (rise-and-fall) of floc was observed at all stations during wave passage. Entrainment of sand was not observed.
- 2) Ripple mark pattern, and accumulation of floc and sediment (sand) similar to that found during diving on transect S1 (0.4 km south of harbor). One shallow depression 0.5-m diameter containing 1-2 cm of floc and silt was seen between stations 1 and 2.
- 3) Two fragments of rock, 10-12 sticks or roots and one metal beverage can were noted.
- 4) Sphaeriid shells were seen primarily at deeper (12.1- and 13.6-m) stations.

Transect S4 (1.6 km south of harbor)

Transect dimensions: length - 1000 m
width - 6.6 m²
area - 6600 m²

Depth range: 7.6-13.6 m

Secchi disc: station 1 - 3.0 m; station 5 - 4.0 m

Water temperature: station 1 - 16.5 C surface, 15.5 C bottom
station 5 - 17.0 C surface, 14.5 C bottom

Air temperature: 15.5 C

Cloud cover: partly cloudy

Wind: NW, 16-24 km/h

Seas: NW, wave height 0.6-1.3 m

Weather: cool, dry, breezy

Station 1 - Depth: 7.6 m
Bottom: medium sand, ripple marks indistinguishable
Organic material: few fish fecal pellets
Biological notes: few sphaeriid shells

Station 2 - Depth: 9.1 m
Bottom: medium to fine sand, ripple marks
indistinguishable
Organic material: few fish fecal pellets, trace of floc
Biological notes: few gastropod shells noted

Station 3 - Depth: 10.6 m
Bottom: fine sand, ripple marks indistinguishable
Organic material: few fish fecal pellets, trace of floc
Biological notes: few gastropods (Gyraulus spp.) were
collected; density was estimated to be
3/100 cm²

Bottom: fine sand, ripple marks variable and poorly developed
Organic material: trace of floc
Biological notes: few sphaeriid shells, few gastropods

Station 5 - Depth: 13.6 m
Bottom: fine sand, ripple marks indistinguishable
Organic material: trace of floc
Biological notes: none

Between-station observations:

- 1) Fine sand and near absence of ripple marks characterized all stations.
- 2) Detritus (primarily wood) was rarely observed.
- 3) One lake trout (about 500 mm) was observed briefly between stations 2 and 3.

Transect S2 (0.8 km south of harbor)

Transect dimensions: length - 650 m
width - 6 m²
area - 3900 m²

Depth range: 7.6-13.6 m

Secchi disc: station 1 - 3.0 m; station 5 - 3.0 m

Water temperature: not available (thermistor malfunction),
temperatures comparable to previous transect
dives

Air temperature: 15 C (estimated)

Cloud cover: partly cloudy

Wind: NW, 32-48 km/h

Seas: NW, wave height 1.0-1.2 m

Weather: cool, dry, windy

- 1) Entrainment and vertical movement of sand by wave action was not observed.
- 2) Sediment graded evenly from medium (inshore, 7.6 m) to fine (offshore, 13.6) sand.
- 3) Trace amounts of floc were observed, primarily at 12-m depths or greater.
- 4) One whorl (1-m diameter, 2-3 m long) of five to six tree branches extending from a short main stem was observed at 10.6 m. Three pieces of wood were noted between 10.6 and 12.1 m.
- 5) Gastropods were observed at stations deeper than 10.6 m.
- 6) A small (10-cm diameter), compact aggregate of terrestrial plant roots and soil (such as might occur along a river bank) was collected at 9.1 m. Laboratory analysis revealed that many isopods and a few amphipods adhered to the surface of the aggregate; the interior was devoid of macroscopic invertebrates. The aggregate was probably of riverine origin, broken from the bank and transported downstream into the lake.

CONCLUSIONS

Transects and stations examined during our 13-14 September dives appeared physically and limnologically uniform. Bottom profile was flat and uninterrupted. With few exceptions (increased abundance of visible snails at deeper stations, occasional occurrence of terrestrial plant material), areas examined appeared relatively uniform biologically. With the exception of some loose algae, all vegetation observed was suspected to be of terrestrial or riverine origin; deposition of these substrates appeared temporary and subject to transport by waves or currents. No unique spawning habitats were identified, but several species of fish, most notably alewife and spottail shiner, would be expected to spawn over the shifting-sand substrate present in the area (Jude et al. 1975, 1978, 1979). Close proximity of Muskegon River, Muskegon Lake, the harbor, and breakwaters would also be expected to attract fish, some (e.g., darters, sculpins, yellow perch) in search of the more protected habitat, others (e.g., carp, darters, rainbow smelt, salmon, sculpins, suckers, yellow perch) seeking spawning areas. In addition, sessile (e.g., Hydra, freshwater sponge and bryozoans) and free-living (e.g., crayfish) invertebrates may be attracted to rocky substrates associated with the breakwaters. Finally, the area of Lake Michigan immediate to the harbor entrance (or river mouth) would be subject to any downstream transport of inorganic or biological materials including pollutants.

SUMMARY

SCUBA observations from transects examined in the vicinity of the Muskegon Harbor breakwaters are summarized below in two categories: physical and biological.

Physical observations --

- 1) Bottom sediments (examined to a depth of 10 cm) consisted entirely of medium or fine shifting sand; sand grains at any given station were of uniform size. Coarse sand, gravel, cobbles, boulders and clay were not encountered.
- 2) Grain size of substrate decreased with increasing depth. In general, medium sand constituted the sediment at 7.6 and 9.1 m while sediment at 12.1 and 13.6 m was composed of fine sand. A distinct transition zone from medium to fine sand was not observed; rather, transition was accomplished gradually between 9 and 12 m. Obvious differences in sand grain size between stations at equivalent depths north and south of the harbor mouth were not apparent.
- 3) A few millimeters of floc were encountered, particularly at deeper stations, but deposition appeared to be temporary with floc subject to resuspension by waves and currents. One small, silt-filled depression was observed (transect N1 - 0.4 km north of harbor).
- 4) Ripple marks were generally shallow (4 cm or less, trough-to-crest), wavelengths were less than 2 cm and marks were not developed consistently from any specific direction. Ripple marks were slightly larger inshore than offshore. At intermediate stations (9.1 and 12.1 m) they were often indistinguishable.
- 5) Bottom profile was flat and even; rises, depressions and sudden drop-offs

were not encountered. Distance from the 7.6- to 13.6-m contour varied between transects as can be concluded from examination of hydrographic maps. Pronounced differences in lake bottom slope were not encountered within or between north and south transects.

6) Vertical and horizontal temperature stratification among all areas examined ranged from 14.5 C to 17.5 C and did not exceed 3 C.

7) Secchi disc readings remained relatively constant ranging from 2.5 to 4.0 m. Horizontal visibility along the bottom decreased with increasing depth as a function of decreased light penetration. Areas of locally elevated turbidity were not encountered but diving was performed outside of the immediate Muskegon River plume which extended directly out from the harbor mouth.

8) Bottom currents were indiscernible to the divers, but surge from surface waves could be felt at all depths. At 7.6 m, the surge entrained floc noticeably; at 13.6 m entrainment was less obvious but discernible upon close examination. Entrainment of sand was not observed. Wave heights during the observational period ranged from 0.6-1.2 m.

Biological observations --

1) A few clumps of loose green algae were noted at 7.6 and 9.1 m during diving on transect N1 (0.4 km north of harbor). Analysis of a sample collected at 7.6 m revealed Cladophora, a green alga, to be the primary constituent; miscellaneous algae and epiphytes were also present. Scattered, small clumps of loose algae were occasionally observed at other transects, but accumulations or patterns of deposition were not evident.

2) Macroscopic accumulations of periphyton were not observed except in association with an occasional large quantity of terrestrial vegetation.

3) Fragments of terrestrial vegetation (primarily wood and bark) were noted in small numbers (less than 10 per transect) during all transect dives. One log (0.5-m diameter, 3 m long) was seen at 10.6 m on transect S1 (0.4 km south of harbor) S1 (0.4 km south of harbor) and one whorl (1-m diameter, 2-3 m long) of five to six tree branches extending from a main stem was observed at 10.6 m on transect S2 (0.8 km south of harbor).

4) Small aggregates (one handful or less) of organic detritus, composed of terrestrial vegetation and unidentified decayed material, were noted occasionally. Floc was often absent, but never more than 2-mm thick at any station.

5) A small (10-cm diameter), compact aggregate of terrestrial plant roots and soil was collected at 9.1 m during diving on transect S2 (0.8 km south of harbor). Many isopods and a few amphipods adhered to the surface of the aggregate; the interior was devoid of macroscopic invertebrates.

6) Aquatic macrophytes were not observed.

7) Snails were observed at about one half of all transect stations; numbers of visible snails increased with depth. Most likely, snails were present at all deeper stations but were not always observed. Ten snails were collected at

10.6 m on transect S4 (1.6 km south of harbor) and preliminarily identified as Gyraulus spp.; density of snails was estimated to be approximately 3/100 cm².

8) Other macroinvertebrates were not observed; however, sphaeriid shells and mollusc trails in the sediment were noted, most often at depths greater than 10.6 m.

9) Fecal pellets of large (probably greater than 30 cm) fish were regularly observed during diving on transect S4 (1.6 km south of harbor).

10) One lake trout (about 500 mm) was observed briefly between 9.1 and 10.6 m during diving on transect S4 (1.6 km north of harbor). Other fish were not observed.

LITERATURE CITED

Jude, D. J., F. J. Tesar, J. A. Dorr III, T. J. Miller, P. J. Rago and D. J. Stewart. 1975. Inshore Lake Michigan fish populations near the Donald C. Cook Nuclear Power Plant, 1973. Spec. Rep. No. 52. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 267 pp.

Jude, D. J., B. A. Bachen, G. R. Heufelder, H. T. Tin, M. H. Winnell, F. J. Tesar and J. A. Dorr III. 1978. Adult and juvenile fish, ichthyoplankton and benthos populations in the vicinity of the J. H. Campbell Power Plant, eastern Lake Michigan, 1977. Spec. Rep. No. 65. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 639 pp.

Jude, D. J., F. J. Tesar, J. C. Tomlinson, T. J. Miller, N. J. Thurber, G. G. Godun and J. A. Dorr III. 1979. Inshore Lake Michigan fish populations near the Donald C. Cook Nuclear Plant during preoperational years - 1973, 1974. Spec. Rep. No. 71. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 529 pp.

